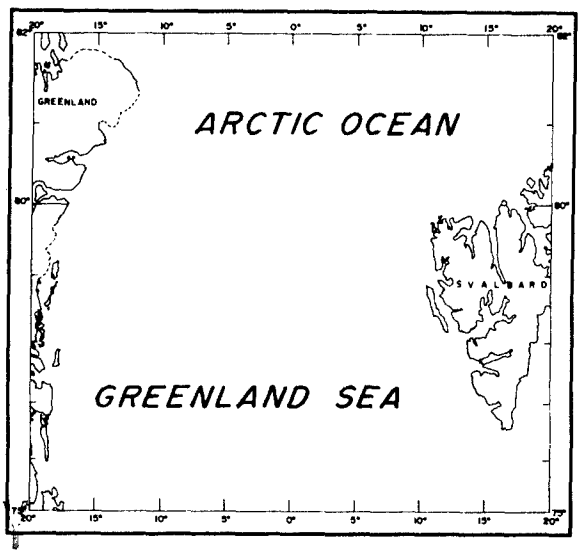
IR NO. 68-10

INFORMAL REPORT

OCEANOGRAPHIC CRUISE SUMMARY WESTERN GREENLAND SEA AUGUST-SEPTEMBER 1965



MARCH 1968

NAVAL OCEANOGRAPHIC OFFICE
WASHINGTON, D. C. 20390

INFORMAL REPORT

The Informal Report (IR) as produced at the Naval Oceanographic Office is a means for personnel to issue timely scientific and technical preliminary reports of their investigations. These are primarily informal documents used to report preliminary findings or useful byproducts of investigations and work to members of the scientific and industrial communities.

Informal Reports are assigned sequential numbers for each calendar year; the digits preceding the dash indicate the year.

The distribution made of this report is determined primarily by the author. Information concerning obtaining additional copies or being placed on a distribution list for all future Informal Reports in a given area of interest or specialty field, should be obtained from:

Distribution Control Department
Code 4420
Naval Oceanographic Office
Washington, D. C. 20390

ABSTRACT

This informal report is a summary of an oceanographic survey in the western Greenland Sea during August and September 1965. Scientists from NAVOCEANO, University of Washington, and University of Massachusetts collected physical, chemical, geological, and biological data from aboard USS EDISTO (AGB 2).

An effort was made to delineate the Polar Front by collecting oceanographic information across the East Greenland Current at several locations. By using the maximum temperature gradient as a guide, the Polar Front was found to closely follow the edge of the Greenland continental shelf. The Polar Front was well defined north of 75° North latitude. South of this latitude, the temperature gradient existed at a shallower depth and the Polar Front decreased in definition.

MARTIN T. BOURKLAND
Ships of Opportunity Branch
Nearshore Surveys Division
Oceanographic Surveys Department

This report has been reviewed and is approved for release as an UNCLASSIFIED Informal Report.

L. B. BERTHOLF
Director, Nearshore Surveys Division

CONTENTS

FIGURES

TABLES

I. PREVIOUS KNOWLEDGE OF THE REGION

An oceanographic survey was conducted by NAVOCEANO during the summer of 1965 in the western Greenland and Norwegian Seas. The East Greenland Current flows through this area along the east coast of Greenland closely following the continental shelf. This current serves as the major outflow of the Arctic Basin. As it flows along the coast, the current is modified by land runoff and North Atlantic Water from the Greenland and Norwegian Basins.

The first significant study in the east Greenland area was done by Scoresby, who investigated the formation, distribution, and movement of ice between 1806 and 1822. Several other studies were made of the East Greenland Current during the 1800's: Irminger, in 1861, surveyed the area around Iceland; Koldewey led the German North Pole expedition in 1869 to 1870; and Ryder, of the Royal Danish Navy, obtained the first transverse section of the East Greenland Polar Current during 1891 and 1892. Results of the FRAM expedition in the North Polar Basin from 1893 to 1896 gave a better understanding of the East Greenland Polar Current and the underlying warmer waters.

The classic study of the area was by Helland-Hansen and Nansen in 1909 using data from the cruises of the MICHAEL SARS during the years 1900 to 1904. They concluded that the main body of the Polar Current flows chiefly along the edge of the continental slope; the current being pressed toward the continental slope by the earth's rotation. The cold, weakly saline Polar Water is confined to the upper 200 meters and flows over the underlying warmer and slower moving Intermediate Water.

The BELGICA expedition of 1905 obtained information of the physical structure of the northern and western parts of the sea between Spitsbergen and northern Greenland.

During the 1920's and 1930's, oceanographic data were collected along the east Greenland coast aboard: GODTHAAB in 1924, 1930, 1932, and 1933; VESLEKARI in 1930; POLARBJORN in 1931 and 1932. In 1945, Kiilerich compiled and prepared a report from previous expeditions in the Greenland Sea. In 1956 and 1958, scientists aboard the U.S.S.R. Ship OB conducted surveys in the Arctic Ocean north of the Greenland Sea.

II. OBJECTIVES OF THE SURVEY

The primary purpose of this survey was to collect oceanographic information across the East Greenland Current in order to delineate the Polar Front. The Polar Front is defined as the boundary between the cold, low salinity water of the East Greenland Current and the relatively warm, high salinity waters carried north by the Norwegian and Spitsbergen Currents. Analyses of the data will enable investigators

to more accurately describe the physical structure, circulation, and interaction of Atlantic and Arctic Basin Waters present in the area.

III. NARRATIVE OF THE SURVEY

Ten scientists, including six from NAVOCEANO, three from the University of Washington, and one from the University of Massachusetts, participated in the survey. All scientific personnel boarded USS EDISTO (AGB 2) at Keflavik, Iceland, and commenced oceanographic observations on 21 August 1965. Survey operations were completed on 18 September 1965.

IV. RESULTS

Personnel aboard EDISTO occupied 47 oceanographic stations in the survey area (crossing the Polar Front at five different locations) and four ice forecasting stations near the southeast coast of Greenland (Fig. 1). In all, 817 serialized depth and temperature observations were recorded, and 795 salinity samples and 791 dissolved oxygen samples were collected and analyzed aboard ship. Micronutrient samples were collected, quick frozen, and returned to NAVOCEANO for analyses. From these samples, 781 reactive silicate analyses and 729 reactive phosphorous analyses were obtained. A total of 44 bottom sediment samples was collected. Foraminifera samples were extracted from the tops of 37 of the bottom samples for the Smithsonian Institution.

Current measurements were made at various depths at six stations; at four of these stations the ship was bow anchored. Other current measurements were made by measuring the drift of the ship while on station. A scientist from the University of Massachusetts collected biological samples from depths of 100 meters or less.

Table I provides a detailed listing of data collected on each consecutive oceanographic station.

V. METHODS OF COLLECTION AND ANALYSIS

A. Physical Oceanography.

1. Temperature. Water temperatures were measured at selected depths by deep sea reversing thermometers paired and attached to Nansen bottles. The accepted temperature values were obtained by applying standard corrections and averaging the two readings if the values differed by 0.05°C, or less. When paired thermometers differed by more than 0.05°C, the reading from the thermometer considered more reliable, based on its previous history, was used. Temperatures are considered accurate to $\pm$0.02°C.

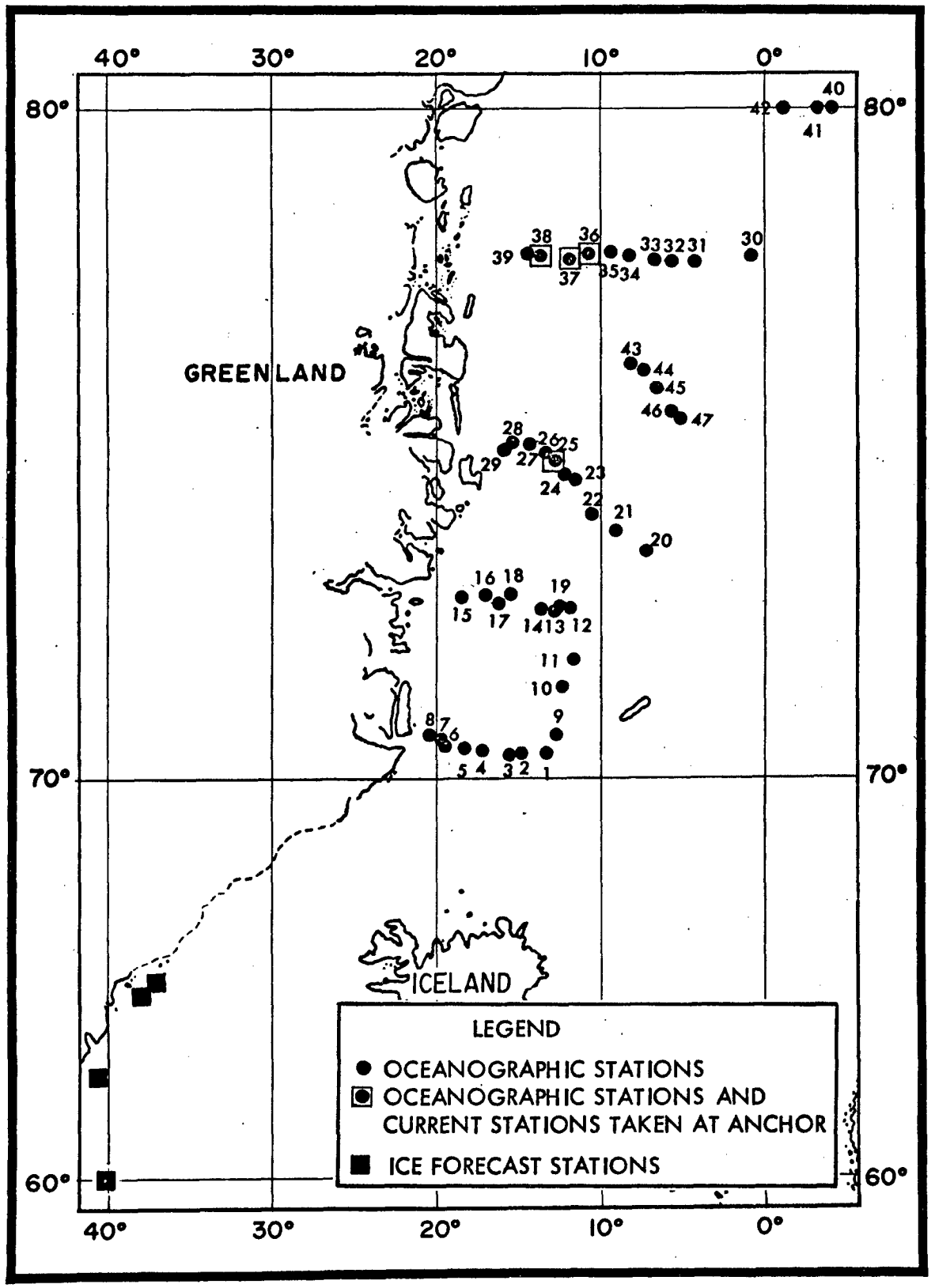


FIGURE 1. STATIONS OCCUPIED BY USS EDISTO (AGB 2) AUGUST-SEPTEMBER 1965

TABLE I. STATION DATA SUMMARY

Stat. No.	Sonic Depth Meters	Cast Depth	Temp./ Sal.	Oxygen	Nutrients	Bottom Samples	Currents	Foram. Samples
1	1006	955	√	√	√			
2	1006	975	√	√	√	core		
3	988	970	√	√	√			
4	1646	600	√	√	√	core		
5	1682	1500	√	√	√	core		
6	1280	1230	√	√	√	core		
7	549	477	√	√	√	core		
8	329	279	√	√	√	core		√
9	732	424	√	√	√	core		√
10	2286	1390	√	√	√	core		√
11	2296	2298	√	√	√	core		√
12	2743	2400	√	√	√	core		√
13	2651	2429	√	√	√	core		√
14	2545	394	√	√	√	core		√
15	284	186	√	√	√	core		√
16	302	259	√	√	√	core		√
17	1554	602	√	√	√			
18	2195	1873	√	√	√	core		√
19	2633	2282	√	√	√			
20	3338	3130	√	√	√	core		√
21	3292	3150	√	√	√	core		√
22	3109	3100	√	√	√	core		√
23	1957	1821	√	√	√	core		√
24	338	330	√	√	√			
25	219	220	√	√	√	core	√	√
26	241	235	√	√	√	core		√
27	260	246	√	√	√	core		√
28	165	165	√	√	√	2 cores	√	√√
29	165	160	√	√	√	core	√	√
30	2963	2674	√	√	√	core		√
31	1737	1418	√	√	√	core		√
32	354	350	√	√	√	core		√
33	265	250	√	√	√	core		√
34	196	200	√	√	√	core		√
35	247	240	√	√	√	core		√
36	205	210	√	√	√	core	√	√
37	152	150	√	√	√	core	√	√
38	132	125	√	√	√	core	√	√
39	82	80	√	√	√	grab		√
40	1170	1081	√	√	√	core		√

TABLE I. STATION DATA SUMMARY (Cont.)

Stat. No.	Sonic Depth Meters	Cast Depth	Temp./ Sal.	Oxygen	Nutrients	Bottom Samples	Currents	Foram. Samples
41	2560	2486	✓	✓	✓	core		✓
42	3374	500	✓	✓	✓	core		✓
43	307	290	✓	✓	✓	core		✓
44	322	290	✓	✓	✓	core		✓
45	1463	1311	✓	✓	✓	core		✓
46	2432	2348	✓	✓	✓			
47	2963	2800	✓	✓	✓	core		✓
48	192	175	✓	✓	✓	grab		
49	622	571	✓	✓	✓	grab		
50	435	215	✓	✓	✓			
51	2468	627	✓	✓	✓			

2. Depth. Unprotected reversing thermometers paired with protected reversing thermometers were used to calculate thermometric depth values.

3. Current. Current measurements were made using a Kelvin-Hughes deck read-out current meter supplied by the University of Washington. The direction sensor failed early in the survey and remained inoperative during the entire operation. Visual sightings of the surface current directions were made to about 10 meters depth. Below this depth the meter could not be seen; therefore, the amount and quality of data are considered insufficient for a detailed analysis.

B. Chemical Oceanography.

1. Salinity. Salinity samples were analyzed on board ship using Industrial Instruments portable induction salinometers (Model RS-7B, serials 90421 and 11871). This instrument is capable of determining salinities with a precision of ± 0.003 ‰. The salinometers were calibrated on board ship by analyzing samples of a known salinity. Salinity values presented in this report are considered accurate to ± 0.01 ‰.

2. Dissolved Gases. A modified Fisher-Hamilton Model 29 gas partitioner was used to determine the amounts of dissolved oxygen and nitrogen in each serial sample collected. This instrument was coupled with a Texas Instrument Model PWSN Integrating Recorder. For comparison, dissolved oxygen samples also were analyzed using a modified Winkler method. Of the two methods, the Winkler data were considered more valid as nitrogen values determined by the gas partitioner appeared to be low.

3. Micronutrients. Samples for mirconutrient analyses were drawn into six-ounce polyethylene bottles, quick frozen, and stored in the ship's freezer. The samples were returned to NAVOCEANO and analyzed for reactive phosphorous in accordance with the method described by Murphy and Riley in 1962 "Determination of Phosphates in Natural Sea Water". Reactive silicate samples were analyzed by the method of Strickland and Parsons in 1965 "A Manual of Sea Water Analyses".

C. Geological Oceanography.

Bottom samples were collected with Kullenberg gravity corers, Phleger corers, and an orange peel bucket sampler. All sediment samples were capped, labeled, wax coated, and returned to NAVOCEANO. The core samples are being analyzed for engineering properties, including specific gravity and liquid and plastic limits; and for particle size and composition, including clay mineralogy and calcium carbonate percentage.

D. Biological Oceanography.

The top few centimeters of 37 of the bottom samples were treated with Formalin and sent to the sorting center of the Smithsonian Institution for foraminiferal analysis.

VI. DISPOSITION OF DATA

The temperature, salinity, micronutrient, and dissolved oxygen data are on file at the National Oceanographic Data Center under cruise reference number 31829. The original current data records are on file at NAVOCEANO. The bottom sediment samples are in the process of being analyzed. The results of these analyses will be presented in NAVOCEANO Geological Laboratory Item Number 275. The foraminifera samples have been analyzed and the results will be presented in a quarterly report of the Smithsonian Institution.

VII. PRELIMINARY ANALYSES

Analysis of the data indicates that the area covered by this survey contains three different water masses: Polar Water, Intermediate Water, and Greenland Sea Bottom Water.

Polar Water, the basic water mass of the East Greenland Current and main outflow of water from the Arctic Basin, flows southward along the east coast of Greenland and is characterized by temperatures less than -1.5°C. The surface layers of the Polar Water of the East Greenland Current are modified by insolation, ice melt, land runoff, and mixing with the warmer surface waters of the Greenland Sea. These factors cause the surface layer to have a higher temperature and lower salinity than that of the underlying Polar Water.

The water mass beneath the Polar Water in the northern latitudes, Intermediate Water, flows south as the Return Atlantic Current. Intermediate Water originates from the Greenland branch of the West Spitsbergen Current and is composed of modified North Atlantic Water. Relatively high temperatures of greater than 0°C and salinities of 34.9 to 35.0 ‰ characterize Intermediate Water. Greenland Sea Bottom Water has temperatures below 0°C and a nearly constant salinity of about 34.92 ‰.

The Polar Front is the meeting of cold Polar Water of the East Greenland Current and the warmer waters introduced by the Greenland and Norwegian Sea gyres. This front is usually found along the continental slope off eastern Greenland. Figure 2 shows the temperature distribution at 10 meters in relation to the edge of the continental shelf. The maximum temperature gradient corresponds closely to the shelf break. The Polar Front was well defined north of 75°N latitude with a gradient of about 0.06°C/km. South of 75°N the front was poorly defined, mainly due to the branching of the East Greenland Current. Here, the temperature gradient of the front is a rather shallow phenomenon correlated with the East Greenland Polar Current. The temperature

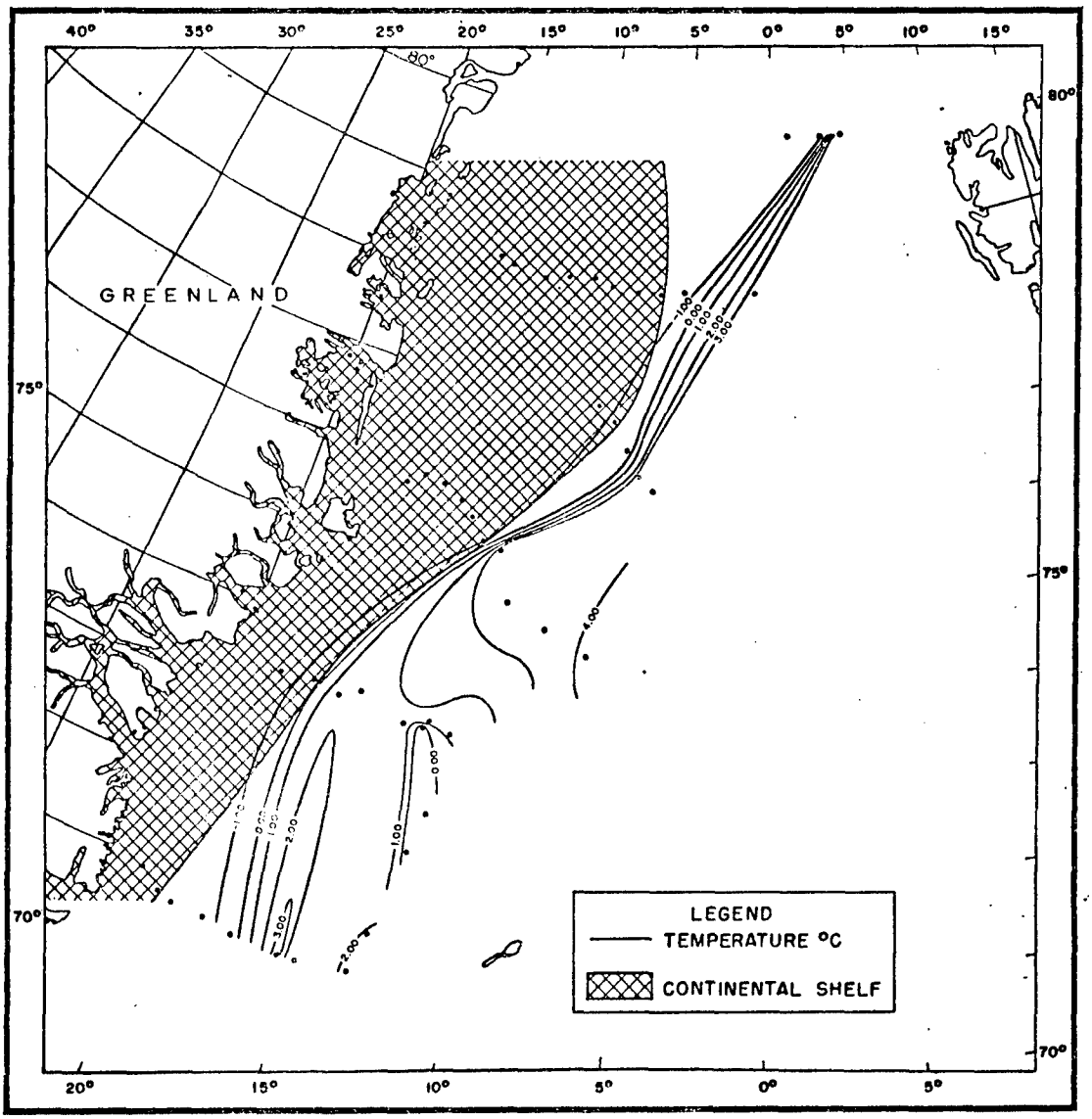


FIGURE 2. TEMPERATURE DISTRIBUTION AT 10 METERS

and salinity profiles in Figure 3 identify the front between stations 30 and 31 near 78°N and show the shallowness of this feature.

Ice coverage in the area closely followed the Polar Front as shown in Figure 4.

The northern cross section (Fig. 3) shows the Polar Water to exist mainly over the shelf and Return Atlantic Water east of the shelf. Coriolis force tends to press the Polar Water against the coast. A slight overlap was found in the region where Atlantic Water met the Polar Water in a southward flow. Farther south (Fig. 5), Polar Water extended east of the shelf and overlaid the Return Atlantic Water.

Though few current observations were made, the current speeds recorded agree with other data collected in the area. The maximum current speed observed was 26 cm/sec on station 36 at approximately 10 meters. Current directions were determined using visual sightings and radar fixes while the ship drifted on station. Current direction was generally southeasterly but the values recorded are not considered to be accurate.

VIII. ADDITIONAL WORK NEEDED IN THE REGION

Additional descriptive oceanographic data are needed along the same cross section tracks made during this survey. This must be done over a period of several years to define annual variations of the physical structure of the East Greenland Current. Additional cross sections in different areas also need to be taken.

Current data in this area are needed. Obtaining current information will be difficult because of the ice which is continually present; nonetheless, accurate current velocities are needed to calculate a mass transport figure for this current and a heat budget for the Arctic Basin.

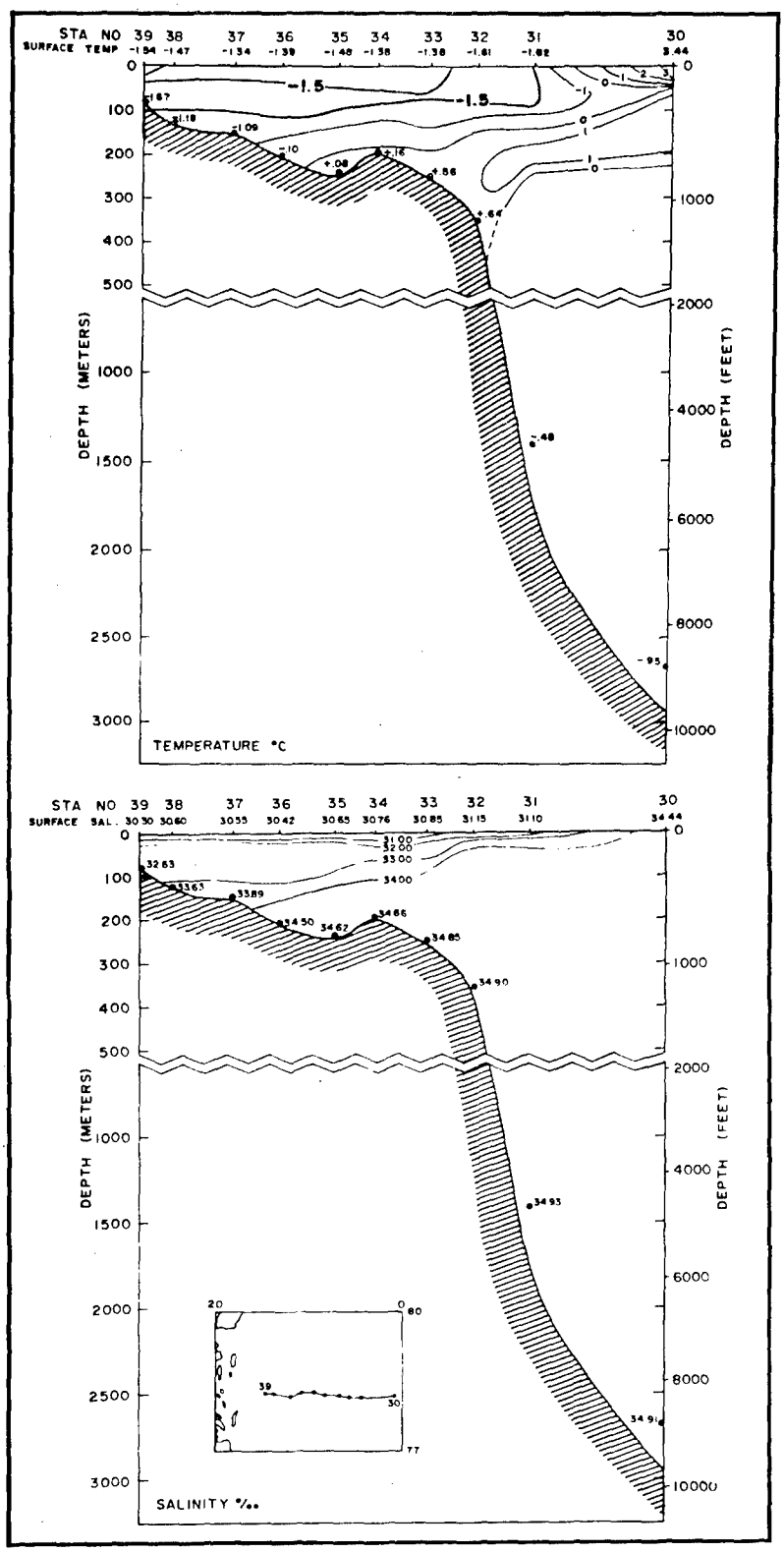


FIGURE 3. TEMPERATURE AND SALINITY CROSS SECTIONS-WEST TO EAST

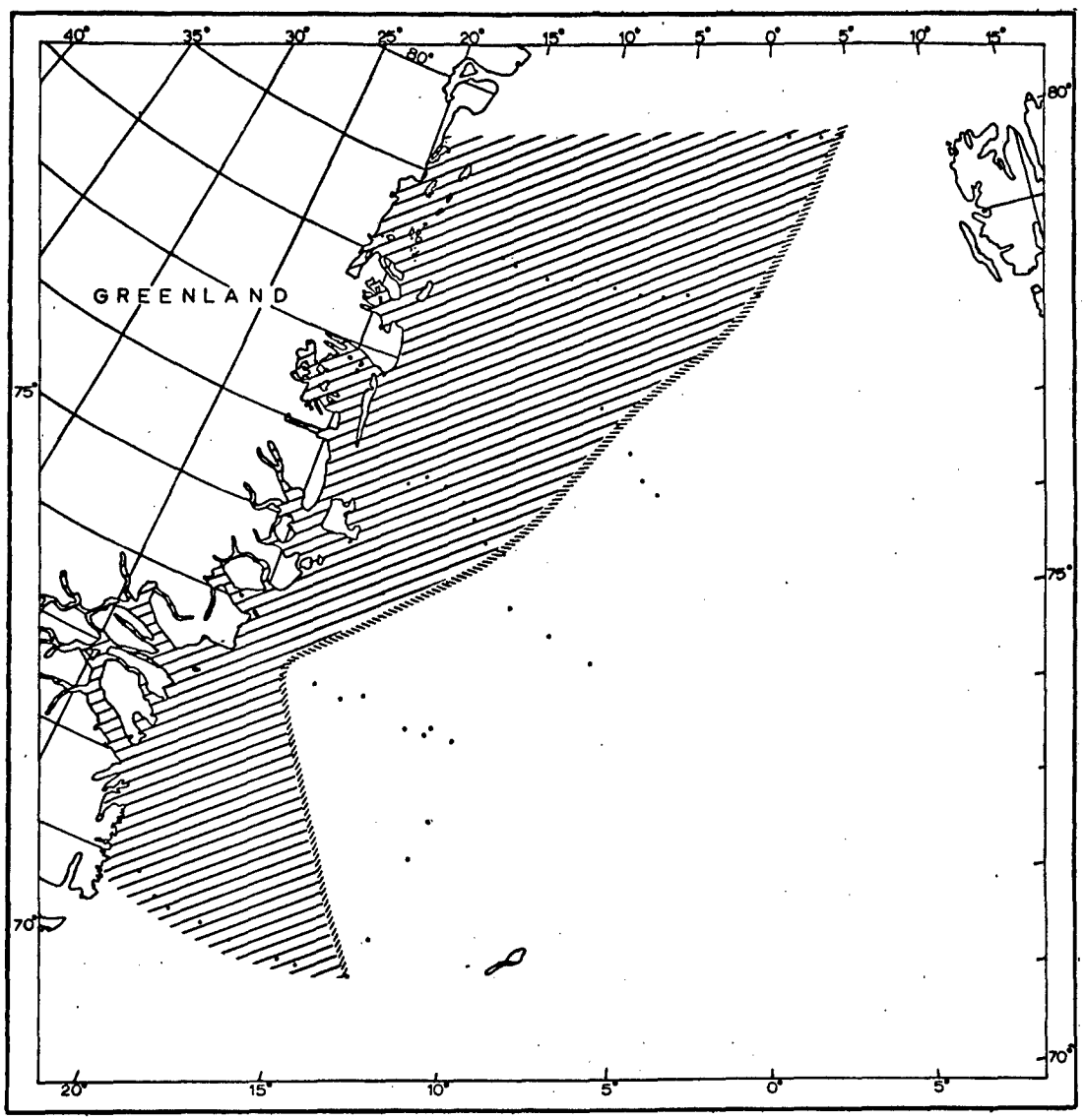


FIGURE 4. ICE COVERAGE OF THE SURVEY AREA

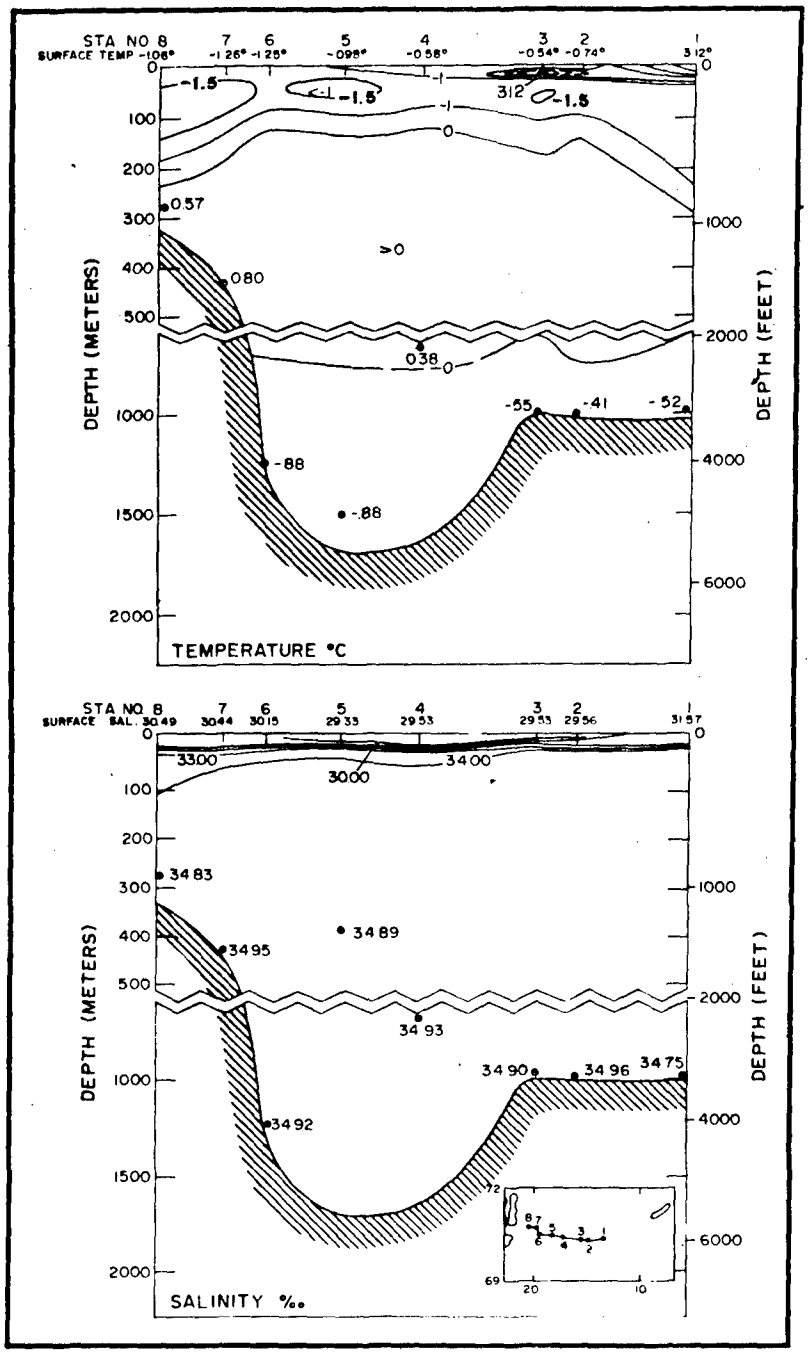


FIGURE 5. TEMPERATURE AND SALINITY CROSS SECTIONS-WEST TO EAST

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*

U. S. NAVAL OCEANOGRAPHIC OFFICE

2a. REPORT SECURITY CLASSIFICATION

UNCLASSIFIED

2b. GROUP

3. REPORT TITLE

OCEANOGRAPHIC CRUISE SUMMARY WESTERN GREENLAND SEA, AUGUST-SEPTEMBER 1965

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

Oceanographic Cruise Summary Informal Report 21 August to 18 September 1965

5. AUTHOR(S) *(First name, middle initial, last name)*

MARTIN T. BOURKLAND

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
March 1968	12	0

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. 202	IR No. 68-10
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. DISTRIBUTION STATEMENT

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	U. S. Naval Oceanographic Office

13. ABSTRACT

This informal report is a summary of an oceanographic survey in the western Greenland Sea during August and September 1965. Scientists from NAVOCEANO, University of Washington, and University of Massachusetts collected physical, chemical, geological, and biological data from aboard USS EDISTO (AGB 2).

An effort was made to delineate the Polar Front by collecting oceanographic information across the East Greenland Current at several locations. By using the maximum temperature gradient as a guide, the Polar Front was found to closely follow the edge of the Greenland continental shelf. The Polar Front was well defined north of 75° North latitude. South of this latitude, the temperature gradient existed at a shallower depth and the Polar Front decreased in definition.

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
OCEANOGRAPHIC CRUISE SUMMARY						
GREENLAND SEA						
EAST GREENLAND CURRENT						
POLAR FRONT						
USS EDISTO (AGB 2)						